CHEMICAL REACTIONS

All chemical reactions have two parts:
(1) A substance that undergoes a reaction is called a _____. In other words, reactants are the substances you start with.
(2) When reactants undergo a chemical change, each new substance formed is called a _____. In other words, the products are the substances you end up with.
The reactants turn into the products.

Reactants → Products

In a chemical reaction, the way atoms are joined is changed. Atoms aren't _____ or destroyed.

DIATOMIC ELEMENTS

There are _____ elements that never want to be alone. They form diatomic molecules.

H_2 , N_2 , O_2 , F_2 , _____ , Br_2 , I_2.

(1 + 7 pattern on the periodic table)

SIGNS OF A CHEMICAL REACTION

The following are indications that a chemical reaction has occurred: formation of a _____, evolution of a gas, _____ change, and absorption or release of

WORDS, SYMBOLS AND ABBREVIATIONS

The arrow separates the reactants from the products. The arrow reads "reacts to _____." The plus sign reads "_____." (s) after the formula implies the substance is a _____. (g) after the formula implies the substance is a gas. (l) after the formula implies the substance is a _____. (aq) after the formula implies the substance is aqueous, a solid dissolved in _____. _____ used after a product indicates a gas, same as (g). ↓ used after a product indicates a _____, same as (s). _____ indicates a reversible reaction. _____ or _____ shows that heat is supplied to the reaction. _____ is used to indicate a catalyst used supplied, in this case platinum. A catalyst is a substance that _____ _____ a reaction without being changed by the reaction. Enzymes are biological or _____ catalysts.

1) Convert the following sentences to chemical equations.

a) Solid iron (III) sulfide reacts with gaseous hydrogen chloride to form solid iron (II) chloride and hydrogen sulfide gas. _____

b) Nitric acid dissolved in water reacts with solid sodium carbonate to form liquid water and carbon dioxide gas and sodium nitrate dissolved in water.

_____

2) Convert the following chemical equations to sentences.

a) $Fe\ (s) + O_2\ (g) \rightarrow Fe_2O_3\ (s)$ _____

_____

b) $Cu\ (s) + AgNO_3\ (aq) \rightarrow Ag\ (s) + Cu(NO_3)_2\ (aq)$ _____

_____

BALANCING EQUATIONS

Atoms can't be _____ or destroyed. All the atoms we start with we must end up with. A balanced equation has the same number of each element on both _____ of the equation.

Rules for Balancing

- Write the correct formulas for all the reactants and products.
- Count the number of atoms of each type appearing on both sides.
- Balance the elements one at a time by adding coefficients (the numbers in front).
- Check to make sure it is balanced.

Never change a _____ to balance an equation. If you change the formula you are describing a different reaction. Never put a coefficient in the middle of a formula. 2 NaCl is okay; Na2Cl is not.

Coefficients are used as _____. Balance elements in the following order: (1) metals; (2) nonmetals; (3) hydrogen; and (4) oxygen

If an atom appears more than once on a side, balance it _____.

If you fix everything except one element, and it is even on one side and odd on the other, double the first number, then move on from there.

3. Balance the following equations.

a) _____ CH_4 + _____ O_2 → _____ CO_2 + _____ H_2O

b) _____ $AgNO_3$ + _____ Cu → _____ $Cu(NO_3)_2$ + _____ Ag

c) _____ Mg + _____ N_2 → _____ Mg_3N_2

d) _____ P + _____ O_2 → _____ P_4O_{10}

e) _____ Na + _____ H_2O → _____ H_2 + _____ NaOH

f) _____ $Pb(NO_3)_2$ + _____ K_2CrO_4 → _____ $PbCrO_4$ + _____ KNO_3

g) _____ MnO_2 + _____ HCl → _____ $MnCl_2$ + _____ H_2O + _____ Cl_2

h) _____ $Ba(CN)_2$ + _____ H_2SO_4 → _____ $BaSO_4$ + _____ HCN

i) _____ $Zn(OH)_2$ + _____ H_3PO_4 → _____ $Zn_3(PO_4)_2$ + _____ H_2O

TYPES OF REACTIONS

Reactions fall into ____ categories:

1. Synthesis
2. Decomposition
3. Single replacement
4. Double replacement
5. Combustion

4) Write and balance the following synthesis reactions.

a) Ca + Cl_2 →

b) Fe + O_2 →

HINT: Use iron (II).

c) K_2O + H_2O →

d) Al + O_2 →

e) SO_3 + H_2O →

f) N_2O_5 + H_2O →

SYNTHESIS REACTIONS

Whenever two or more substances combine to form _____ single product, the reaction is called a synthesis reaction.

Key: **M** = Metal ; **NM** = Nonmetal

1. **SYNTHESIS:**

a. Formation of binary compound:

A + B → AB

b. Metal oxide and water:

MO + H_2O → base

(A base is a metallic _____.)

c. Nonmetal oxide and water:

(NM)O + H_2O → acid

(The acid will be a _____ acid.)

Always remember to check the oxidation numbers of the ions in the product to see if you need to criss-cross before balancing.

DECOMPOSITION REACTIONS

The word decompose implies the compound will "fall apart." In a decomposition reaction, one compound breaks down into _____ or more simpler substances.

a. Binary compounds: **AB → A + B**

b. Metallic carbonates: **MCO_3 → MO + CO_2**

c. Metallic hydrogen carbonates: **$MHCO_3$ → MO** (*s*) **+ H_2O** (*l*) **+ CO_2** (*g*)

d. Metallic hydroxides: **MOH → MO + H_2O**

e. Metallic chlorates: **$MClO_3$ → MCl + O_2**

f. Oxyacids decompose to nonmetal oxides and water: **acid → (NM)O + H_2O**

5) Use the Chemistry Reference Tables to write and balance the following decomposition reactions.

a) $KClO_3$ →

b) $CaBr_2$ →

c) Li_2CO_3 →

d) $Cr(OH)_2$ →

e) $NaHCO_3$ →

f) HNO_2 → (Dinitrogen trioxide one of the products.)

SINGLE REPLACEMENT

In a single-displacement reaction, one element takes the place of another in a compound. One reactant must be an element, and the one reactant must be a _____. The products will be a different element and a different compound. Remember zinc, Zn, always forms a _____ ion doesn't need parenthesis. In addition, silver, Ag, always forms a _____ ion. Some single replacement reactions do not occur because some elements are not as _____ as others. A more active element _____ a less active element. There is a list referred to as the Activity Series on page 7 of your Chemistry Reference Packet. A higher element on the list replaces lower element. If the element by itself is lower on the list, the reaction will _____ occur.

SINGLE REPLACEMENT, CONT.

a. Metal-Metal replacement: **A + BC → AC + B**
b. Active metal replaces H from water: **M + H_2O → MOH + H_2**
c. Active metal replaces H from acid: **M + HX → MX + H_2**
d. Halide-Halide replacement: **D + BC → BD + C**

6. Write and balance the following single replacement reactions.

a) Rb + AlN →
b) Zn + HCl →
c) Ag + $CoBr_2$ →
d) Ag + H_2O (steam) →
e) Cu + H_2SO_4 →
f) Cr + H_3PO_4 → (HINT: Use Cr^{3+})
g) Ca + H_2O (steam) →
h) Br_2 + KCl →
i) Cl_2 + KI →

DOUBLE REPLACEMENT

In double-displacement reactions, the positive portions of two _____ compounds are interchanged. The reactants must be two ionic compounds or _____. Double replacement reactions usually take place in _____ solution. The _____ ions change place. You must check to see if you need to criss-cross the products and then balance. A double replacement reaction will only happen if one of the products: (1) doesn't dissolve in water and forms a _____, (2) is a _____ that bubbles out, or (3) is a _____ compound usually water.

DOUBLE REPLACEMENT: AB + CD → AD + CB
a. Formation of a precipitate from solution
b. Acid-Base neutralization

NET IONIC EQUATIONS

In molecular equations, the formulas of the compounds are written as though all species existed as molecules or whole units. An ionic equation shows dissolved _____ compounds in terms of their free ions. Ions that are not involved in the overall reaction are called _____ ions. The net ionic equation indicates only the species that actually take part in the reaction. The following steps are useful for writing ionic and net ionic equations:

1) Write a balanced _____ equation for the reaction.
2) Rewrite the equation to indicate which substances are in ionic form in solution. Remember that all soluble salts (and other strong electrolytes), are completely dissociated into _____ and anions. This procedure gives us the ionic equation.
3) Lastly, identify and cancel spectator ions on both sides of the equation to arrive at the net ionic equation.

7. Write and balance the following double replacement reactions. Assume the reaction takes place. In addition, identify the precipitate and write the net ionic equation.

a) $CaCl_2 + NaOH \rightarrow$

b) $CuCl_2 + K_2S \rightarrow$

c) $KOH + Fe(NO_3)_3 \rightarrow$

d) $(NH_4)_2SO_4 + BaF_2 \rightarrow$

8. Write and balance the following acid-base double replacement reactions.

a) $HCl + Ca(OH)_2 \rightarrow$

b) $H_3PO_4 + CuOH \rightarrow$

COMBUSTION

A combustion reaction is one in which a substance rapidly combines with _____ to form one or more oxides. Combustion reactions involve a compound composed of only _____ and H (and maybe O) that is reacted with oxygen gas. If the combustion is complete, the products will be CO_2 and _____. Combustion reactions produce heat, and are therefore considered _____ reactions.

Hydrocarbon + oxygen → carbon dioxide + water

A hydrocarbon is a compound that contains both _____ and carbon.

9. Complete and balance the following combustion reactions.

a) $C_4H_{10} + O_2 \rightarrow$

b) $C_6H_{12}O_6 + O_2 \rightarrow$

c) $C_8H_8 + O_2 \rightarrow$

d) $C_3H_8O_3 + O_2 \rightarrow$

How to Recognize Which Reaction Type: Look at the reactants. (E = element; C = compound)

E + E or oxide + water	Synthesis
C	Decomposition
E + C	Single replacement
C + C	Double replacement
hydrocarbon + O_2	Combustion

10. Identify whether the reaction is synthesis (S), decomposition (D), single replacement (SR), double replacement (DR) or combustion (C).

_____ a) $H_2 + O_2 \rightarrow$

_____ b) $H_2O \rightarrow$

_____ c) $Mg(OH)_2 + H_2SO_3 \rightarrow$

_____ e) $KBr + Cl_2 \rightarrow$

_____ f) $Zn + H_2SO_4 \rightarrow$

_____ g) $AgNO_3 + NaCl \rightarrow$

_____ d) $HgO \rightarrow$ _____ h) $C_6H_6 + O_2 \rightarrow$

BALANCING EQUATIONS WORKSHEET

On your own paper, balance the following equations.

SYNTHESIS

1. $S + O_2 \rightarrow SO_2$
2. $S + O_2 \rightarrow SO_3$
3. $P + O_2 \rightarrow P_2O_3$
4. $Mg + N_2 \rightarrow Mg_3N_2$
5. $N_2 + O_2 \rightarrow NO_2$
6. $Na + O_2 \rightarrow Na_2O$
7. $Cu + S \rightarrow Cu_2S$
8. $Al + N_2 \rightarrow AlN$
9. $Hg + I_2 \rightarrow HgI_2$
10. $Fe + O_2 \rightarrow Fe_2O_3$

DECOMPOSITION

11. $HgO \rightarrow Hg + O_2$
12. $MgSO_4{\cdot}7H_2O \rightarrow MgSO_4 + H_2O$
13. $KClO_3 \rightarrow KCl + O_2$
14. $NH_4NO_3 \rightarrow N_2O + H_2O$
15. $NaNO_3 \rightarrow NaNO_2 + O_2$
16. $BaO_2 \rightarrow BaO + O_2$
17. $H_2O_2 \rightarrow H_2O + O_2$
18. $NO_2 \rightarrow N_2 + O_2$
19. $CaCO_3 \rightarrow CaO + CO_2$
20. $H_2O \rightarrow H_2 + O_2$

SINGLE REPLACEMENT (SINGLE DISPLACEMENT)

21. $AlI_3 + Cl_2 \rightarrow AlCl_3 + I_2$
22. $CH_4 + Cl_2 \rightarrow CHCl_3 + HCl$
23. $Al + CuSO_4 \rightarrow Al_2(SO_4)_3 + Cu$
24. $Fe_2O_3 + Al \rightarrow Al_2O_3 + Fe$
25. $Zn + HCl \rightarrow ZnCl_2 + H_2$
26. $ZnS + O_2 \rightarrow ZnO + SO_2$
27. $Na + H_2O \rightarrow NaOH + H_2$
28. $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$
29. $Zn + NaOH \rightarrow Na_2ZnO_2 + H_2$
30. $AgNO_3 + Zn \rightarrow Zn(NO_3)_2 + Ag$

DOUBLE REPLACEMENT

31. $Fe(OH)_3 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2O$
32. $AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + KNO_3$
33. $AgNO_3 + CuCl_2 \rightarrow AgCl + Cu(NO_3)_2$
34. $Pb(NO_3)_2 + HCl \rightarrow PbCl_2 + HNO_3$
35. $MgCl_2 + NaOH \rightarrow Mg(OH)_2 + NaCl$
36. $AgNO_3 + H_2S \rightarrow Ag_2S + HNO_3$
37. $CaCO_3 + HCl \rightarrow CaCl_2 + H_2CO_3$
38. $Hg_2(NO_3)_2 + NaCl \rightarrow Hg_2Cl_2 + NaNO_3$
39. $BaCl_2 + (NH_4)_2CO_3 \rightarrow BaCO_3 + NH_4Cl$
40. $Al(OH)_3 + NaOH \rightarrow NaAlO_2 + H_2O$

COMBUSTION

41. $CH_4 + O_2 \rightarrow CO_2 + H_2O$
42. $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$
43. $C_3H_6 + O_2 \rightarrow CO_2 + H_2O$
44. $C_5H_8 + O_2 \rightarrow CO_2 + H_2O$
45. $CH_3OH + O_2 \rightarrow CO_2 + H_2O$
46. $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$